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## FOREST INSECT PROBLEMS ENCOUNTERED AT THE INSTITUTE OF FOREST GENETICS, 1925 - 1948

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INDEX

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U. S. DEPARTMENT OF AGRICULTURE
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FOREST INSECT INVESTIGATIONS

# FOREST INSECT PROBLEMS ENCOUNTERED AT THE INSTITUTE OF FOREST GENETICS, 1925 - 1948

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# FOREST INSECT PROBLEMS ENCOUNTERED AT THE INSTITUTE OF FOREST GENETICS, 1925 - 1948

A review of correspondence files and other records reveals that a wide variety of insects injurious to forest trees have been encountered in the tree breeding program of the Institute of Forest Genetics since its inception. All of these insects are native to the east side Sierra pine type. Thus far no introduced pests have appeared due to the careful inspection of seed shipments and young pines which have been brought in from other states and countries for planting in the nursery and Eddy Arboretum. However, the large number of exotic conifers and new hybrids which have been propagated and are now growing have produced some new insect-host relationships. The native forest insect populations have moved in from surrounding areas and attacked not only their natural host trees in the arboretum and progeny blocks, but have also tried out some of the introduced species with varying degrees of success.

This summary has been prepared to serve as a record of entomological developments in the tree breeding program during the past 23 years. This period should be long enough to serve as an indication of what to expect as time goes on.

## I. INSECTS ATTACKING CONES, CATKINS, AND SEEDS

### 1. Ponderosa pine seed chalcid, (Megastigmus albifrons, Walk.)

#### a. Occurrence.

In 1930 Dr. F. I. Righter found a high percent of ponderosa pine seeds infested by the larvae of a seed chalcid in a series of cones which had been hand pollinated for breeding purposes. These were determined as M. albifrons. This species of seed chalcied was found near Placerville in 1912 by J. M. Miller, which provided the first record of its host and locality, the insect having been described years before from specimens for which these data were unknown. Available records since then seem to limit its distribution to the west side pine belt of the Sierras.

In 1943 Dr. J. T. Buchholz, of the University of Illinois, encountered young larvae of this seed chalcid in his embryological studies of ponderosa pine at Placerville. His material came from unbagged cones.

In 1947 Dr. Righter collected chalcid infested seeds from bagged ponderosa pine cones near Silver Fork, at an elevation of 6,000 feet. These cones had been pollinated with pollen from the Jeffrey-Coulter hybrid and were bagged for the second year on May 16. Apparently this date was too late to prevent attack by an early emergence of the chalcid which occurred that season.

b. Character of injury

The female chalcid attacks the cones soon after they begin their second year of growth. The ovipositor is forced down through the cone scales and into the soft tissues of immature seed where the egg is deposited. As growth continues through the season the seed forms a normal outer coat but the interior is occupied by the larva. There are no castings as the feeding habit of the larvae appears to be of a gall-forming nature. The larva remains within the seed coat until the following spring when the adult forms and cuts its way through the shell to emerge leaving a clear-cut emergence hole. This emergence hole is the first external evidence of chalcid activity. Up until emergence infested seeds look just like normal seeds and can be detected only by a difference in weight.

c. Control

Cones can be protected from attack by bagging during the second year of growth. It is important that the bags go on before the attack of the newly emerged adults begins. This date is subject to considerable seasonal variation, but usually occurs between May 1 and June 15. The start of the second year growth by the cones should be a good indicator for timing the bags.

2. Cone pith moths, (Laspeyresia toreuta)

a. Occurrence

Both ponderosa and Jeffrey pines are subject to infestation by the larvae of these moths. Infestations have been frequently encountered in the seed collecting program of the Institute although correspondence records are lacking. The most common species is Laspeyresia toreuta, which is very generally distributed throughout the western pine region.

b. Character of injury

The moth lays its eggs on the outer surface of the cone scales about two or three weeks after the cones begin their second year of growth. As soon as the egg incubates the tiny larvae works through the scales to the axis of the cone, making a barely perceptible mine. In the pith of the axis it soon makes well formed tunnels which are lined with a white membrane. When the seeds are fully formed the larva runs branch tunnels from the cone axis into the seeds and feeds on the cotyledons, leaving the outer shell of the seed intact except for the one hole by which it enters and leaves. These hollow seeds are usually held in the cone after it opens by the membrane of the larval mines, so they usually do not appear in any quantity in collected seeds. The larvae overwinter in the cone axis or in the hollow seeds. In the spring pupae are formed in the tunnels or in the hollow seeds and the moths emerge in May and June.

c. Control

Bagging of the second year cones has been quite effective in preventing attack by these pith moths. The attack comes after the cones are well started on their seasonal growth, so that bagging by June 1 is effective.

3. Cone moths, (Dioryctria spp.)

A report by Dr. A. J. West in 1936 lists Dioryctria ponderosae larvae as feeding on pine foliage in the arboretum and nursery. Certain species of this genus, D. abietella and D. xyanthobares are known to feed on cones, although there are no records of their having been encountered in the cone collecting work of the Institute. In June 1947 an undetermined lepidopterous larvae feeding in the cones of western white pine was reported by Righter. Some of this material was put in rearing but no adults were obtained.

4. Ponderosa pine cone beetle, (Conophthorus ponderosae, Hopk.)

a. Occurrence

The work of this beetle has been observed frequently in the seed collecting work of the Institute, and in two cases it was found in hosts other than ponderosa pine. In September 1946, Cumming found the cones of Washoe pine and Jeffrey pine in the Mt. Rose district had been killed by a cone beetle which was determined as C. ponderosae. In September 1947, Righter found bagged cones of ponderosa pine which had been killed by this beetle. In some cases the attack may have been made before the cones were bagged, but on a number of cones it was evident that beetles had bored into the cone after the bags were put on. This was accomplished by starting the entrance tunnel at the point where the bag was tied around the stem and boring in underneath the seal.

b. Character of injury

Adult beetles emerge in May and early June. They attack the base of the second year cone, when it is about 1/4 to 1/2 grown. The tunnel at first circles the base of the cone in an effective girdling action which causes it to die very quickly. The tunnel is then extended out through the cone axis and in this eggs are deposited. Larvae feed on dying tissues of axis, scales, and seeds. Larvae are active for about six weeks, pupate and transform to new adults in the dead cones before the end of summer. Most of the new adults overwinter in the dead cones which adhere to the trees and emerge the following spring.

c. Control

Bagging usually protects cones from attack, but tight sealing of the open end of the bag below the base of the cone is necessary to insure protection.

5. Sugar pine cone beetle,(Conophthorus lambertianae Hopk.)

a. Occurrence

A heavy toll of the sugar pine crop is often taken by this beetle and it has been frequently noted in seed collection. Sugar pine cones drop to the ground within a few weeks after they are attacked and the amount of damages is thus quite noticeable. In 1943 Cumming found some bagged sugar pine cones which had been killed by the beetle and attributes this attack prior to bagging.

b. Character of injury

Adults attack first the peduncle of the second year cone, usually causing a distinct pitch tube to form. The tunnel is then extended outward through the peduncle and into the axis of the cone where the eggs are laid. Cones are attacked when they are from 1/4 to 1/2 grown and soon die and drop. The larvae feed in the dying tissues of the cone, mature and produce new adults before the end of summer. Some of these new adults emerge from the cones in late August and September and make short burrows in the twigs of living sugar pines, an apparent feeding habit preparatory to overwintering; other adults apparently overwinter in the fallen cones.

c. Control

Bagging of second year cones to include the peduncle should be done before June 1 to prevent attack.

6. Pollen maggot, (Diptera).

Almost every year a number of small white larvae are extracted with the pollen from ponderosa pine catkins collected for pollination purposes. The adult form of this insect has never been obtained and the species is unknown, although it is perhaps the most abundant insect encountered in the pollination program.

In June 1946 great numbers of these slender white larvae were obtained in pollination extractions. Duffield collected a quantity for rearing by the Forest Insect Laboratory, but all died before pupation.

This diptera has been found in various pine areas of California and is known to infest ponderosa, Jeffrey and lodgepole pine. Its feeding period apparently lasts only for the few days that the catkins are in flower. As soon as the pollen starts to shed, the larvae leave the catkins and drop to the ground, where they disappear in the duff or soil. A number of attempts have been made by forest entomologists to rear the adults by keeping larvae that have emerged from the catkins in soil and duff, but all attempts have been unsuccessful. Apparently the larvae do not destroy enough of the pollen to be a serious factor in seed fertilization and control is unnecessary.

## II. INSECTS ATTACKING THE ROOTS OF SEEDLINGS AND YOUNG TREES

### 1. Cut worms

No heavy infestation of cut worms have been reported, but their occurrence in the nursery beds has been about normal. Poison bait has been used regularly to keep them under control.

### 2. White grubs, (Pleocoma fimbriata).

#### a. Occurrence

This common California June beetle is the only one recorded that has caused trouble in plantings of the Institute. Some damage occurred in the 1937 planting area, which was cleared of considerable growth of manzanita and ceanothus before the pines were set out. After the young pine trees were in a number died during the first and second seasons because of root injury by large white grubs. Professor E. O. Essig visited the area at that time and identified the insect as Pleocoma fimbriata. No control, other than replanting, was proposed and the trouble cleared up within two or three years after the planting was made.

#### b. Character of injury

The larvae of this species live in the ground for several years where they feed on the roots of native brush species. When the land is cleared they are thus deprived of their natural food and will attack the roots of planted conifers or other trees. The infestation will not thrive on conifers and soon dies out, however, where the brush species have been removed.

## III. INSECTS ATTACKING NEEDLES AND STEMS OF YOUNG TREES IN NURSERY AND OUT PLANTINGS

### 1. Pine tip moth, (Rhyacionia zozana).

#### a. Occurrence

This was the first insect problem to come up in the planting program of the Institute. In 1925 Mr. Austin wrote to the Forest Service nursery at Halsey, Nebraska, asking their advice for avoiding tip moth infestations in shipments of pine seedlings which he was importing. So far as known the tip moth species of the Halsey plantations has not been introduced in the Placerville area. A native tip moth, however, of the same genus caused considerable concern in the earlier plantings.

In June 1926 adult moths reared from a pupa collected from ponderosa pine at the Institute were identified in Washington as Rhyacionia sp. Later collections, particularly those by H. G. Baumhofer who visited the Institute in 1930, resulted in specimens which were finally determined as R. zozana. In 1928 tip moth injury was so prevalent that in the arboretum plantings control was undertaken. The method first used was hand picking of the larvae in the infested shoots. The following year a lead arsenate spray was applied but for a number of years following hand picking was used as the simplest and cheapest method of control. Tip moth infestations began to subside about 1936.

In June 1937 Berriman reported that it had disappeared. The growth of trees in the arboretum may have had much to do with its subsidence since this tip moth does most of its damage to trees during the first decade of their growth. It is mentioned, however, in later reports by Yuill and, during 1946, was found on younger trees in the nursery and plantings. Control, however, has been largely discontinued since 1937 except for occasional hand picking of badly infested young trees in the nursery.

b. Character of injury

The larvae begin working on the new shoots of ponderosa and Jeffrey pines. In 1948 it was found attacking shoots of the hybrid PJ x PJ x PC. This or a similar species was found in white pine. The larvae work first around the bases of the needle fascicles; as the larvae become larger they enter the shoot killing the terminal bud. Pupae are usually formed inside the shoot and moths emerge the following spring.

c. Control

This insect does not kill the tree but causes deformation by killing the leaders on lateral limbs. Control is needed only when infestations become very heavy. Hand picking is practical on small trees. Some of the new insecticides may be more effective than the lead arsenite formulae which was first recommended. Natural parasites apparently hold down tip moth infestations over long periods.

2. Needle tyer (Zelleria haimbachi - Busck. Family Hyponomeutidae)

The species was present in 1928 when it was noticed on ponderosa pines in the nursery. In 1947 it became very prevalent damaging severely the 11-year-old ponderosa trees in the Institute Transect planting. In 1948 it was prevalent on the Jeffrey-Coulter hybrid outplanting and was found on nearly all pines including Coulter, Jeffrey, Jack pine, lodgepole, and ponderosa. Moths were determined from rearings of 1947 larvae recorded under Hopk. U. S. 33756a.

Character of injury

This is not a typical needle tyer but the term has been used to distinguish it from the tip moth. The larvae begin working on the new shoots in May and do most of their damage before growth is completed. They cover the resinous green bark of the new shoot with a white protection web and mine into the needle fascicles, usually killing the needles before they are half grown. This type of feeding resembles somewhat that of the tip moth, but the needle tyer does not enter the shoot or kill the terminal bud. The damage is, therefore, limited to the loss of needles on the infested shoots. Pupae are formed in the webbing along the shoot; moths emerge in June and July. Complete life history is not known, but it is probable that the eggs are laid during the summer on the terminal buds and that the insects overwinter either as eggs or tiny dormant larvae in the new buds.

Control

No remedies have been developed for this species. The best possibilities for control will apparently be to spray the trees just after the buds open so as to kill the young larvae as they begin feeding.

3. The resin midge, (Retinidiplosis sp.)

a. Occurrence

In June 1923 Miller reported the resin midge in ponderosa pines near the Institute. In 1935 Austin called attention to the seriousness of resin midge infestation in the arboretum planting. At this time the insect was in epidemic numbers throughout the lower ponderosa pine belt and the conspicuous injury to arboretum trees was probably due to the fact that all trees had reached the age when they are most susceptible to resin midge damage. When trees are about 10 years of age they may become badly deformed and stunted from resin midge attack although few will die.

In 1936 A. J. West reported on resin midge at the Institute and recommended spray control. This was undertaken but only partial success attained according to a report by Yuill.

In 1937 and 1938 resin midge control was seriously undertaken at the Institute with special formulae developed by Yuill, who also made biological studies and suggested that parasitism be explored as a possible means of control. Further spraying was done in 1939 and 1940. Best results were obtained in 1940 when 70 to 90 percent mortality of the larvae was obtained.

In 1941 the midge was still present but since that date it has disappeared almost completely in the arboretum and plantings.

b. Nature of injury

The midge attacks only ponderosa pine and confines its work mainly to juvenile trees although the lower limbs of large trees sometimes become infested. The eggs are deposited in May and June on the bark surface of the tender, new shoots. The larva enters the phloem where it forms a resinous pit in which it feeds during its entire development. The bark and wood tissues around this pit become heavily infiltrated with resins and produce a scar, which in many cases results in death of needle tufts and twigs. Conspicuous "flagging" needle tufts and branches are indicators of resin midge infestations. Killing of twigs and terminals causes deformation of heavily injured trees.

c. Control

The resin midge is apparently held in check for long periods by its parasites and natural enemies. Spray applications with formulae devised by Yuill are effective if applied before the new shoot growth becomes too far advanced.

4. Pine reproduction weevil, (Cylindrocopturus eatoni Buchanan)

a. Occurrence

According to records of the Forest Insect Laboratory, this weevil was first found in the nursery of the Institute of Forest Genetics in young ponderosa pines of the scopulorum variety. Collected by C.R. Berriman, Feb. 1930, in P.p. scopulorum, 1928 nursery (17944a) It did not attract attention, however, until 1946 when a heavy center of infestation was found in the P. scopulorum progeny block. A study of the block revealed that the infestation had been developing in that area since 1942. During the season of 1946 it was usually aggressive, not only in the scopulorum block but in the arboretum and nursery where it attacked P. montana, P. murrayana, and a hybrid P. murrayana x P. banksiana. Close examination of the nursery bed of lodgepole pine indicated that about 15 2-year-old trees had been killed by the weevil in 1945, which at the time was attributed to drought.

Control measures were carried out in the spring of 1947 by eradication of the overwintering infestation and by spraying the susceptible scopulorum trees with a DDT emulsion. This reduced the weevil population so far that loss of trees was negligible in 1947, only 2 unsprayed scopulorum trees being attacked in the arboretum.

b. Character of injury

Adults which emerge in late May, June, and early July first make feeding punctures in the needles, and later on the thin barked internodes of the main stem and branches. Eggs are deposited in or adjacent to necrotic areas which form in the inner bark around the punctures. Larvae feed first in the necrotic areas, and then extend mines into the living cortex and phloem. Susceptible trees die by the first of October, when the larval mines have reached the wood, which the larvae then enter and form overwintering cells. Resistant trees contain the larvae within the necrotic areas where they die during the fall and winter.

c. Control

Trees containing overwintering larval broods are easily recognized during the winter and spring. These are easily destroyed by burning.

Living trees can be protected from attack by application of a DDT emulsion to foliage and stems. Since the adult weevils run about over the needles and bark for a considerable period of the summer, they are highly vulnerable to a DDT deposit on the surface.

5. Red spider, (Paratetranychus sp.)

a. Occurrence

Red spiders were mentioned in Yuill's report of conditions for the season of 1938. They caused considerable fading of small trees in the Bassi transect plantation and at the Institute. Rains during the fall of 1938 greatly reduced it. It was much less numerous in 1939, and was reported again by Weidman in 1941 as being bad in the 1937 progeny plantation. Each year some evidence of red spiders has been encountered. These insects are always present but it has been mainly when trees are suffering from drought that they show distress from red spider.

b. Character of injury

Needles turn yellow from feeding of the mites.

c. Control

Watering when trees show distress -- a spray formulae was recommended by Yuill which controlled both red spider and aphis.

6. Species of minor importance

a. Aphids. A species of aphis appears at times on ponderosa and Jeffrey pines in the nursery, but soon disappears or is easily controlled. It was first reported by West in 1936. Yuill reports it in 1938, 1939, and 1941 and recommended spraying. In 1946 and 1947 it appeared late in the summer on ponderosa and Jeffrey pines. (Hopk. U.S. 33763a) Specimens collected in 1947 were identified as Schizolachnus pini-radiatae Davidson. Nicotine sprays have given effective control.

b. Chermes

Plant lice of this genus are sometimes common on pines in the nursery. These form small white cottony masses on the needles which are quite conspicuous and easily recognized. In 1946 Duffield called attention to the abundance of chermes on young knobcone pine growing with the knobcone-Monterey pine hybrid in the nursery. There was a marked selection of the knobcone pines which was 100 percent infested; the hybrid was only lightly infested. The same conditions were repeated in 1947. In 1948 chermes were noticeable on scopulorum and Coulter pines enclosed in the weevil-testing cages.

So far chermes have not caused serious damage to trees at the Institute. Lady bird beetles and other natural factors are quite effective in keeping them under control, so that infestations are usually sporadic and short-lived.

c. Scales

Scale insects have been a minor factor, and are mentioned only once — Yuill in 1938 reported that the white pine leaf scale, Aspidiotus pini was numerous near dusty roads.

d. Scythropus beetle.

This is a large bronze colored weevil which is common on pine needles in the spring. Feeding of the adults produces saw-toothed edges of the needles but actual damage is negligible. It was reported by West in 1946.

e. Grasshoppers

Grasshoppers have been a threat to recently planted trees in grass areas. In 1940 they became serious in the Bassi plantation and outplantings at the Institute. Poison mash was used for control. 1941 and 1943 were also bad grasshopper years causing damage both to pines and young cork oak. Poison mash spread around the trees has been fairly effective as a control measure. Apparently feeding on forest trees by grasshoppers is only "incidental" and they are easily attracted from the trees to the bait.

IV. INSECTS ATTACKING STEMS OF SAPLINGS AND MATURE TREES

Up to the present time most of the plantings of the Institute have not reached the age when the trees become susceptible to bark-beetles and other cambium feeding insects that thrive best in mature stands. This condition may not be long delayed, however, as some trees in the arboretum and progeny plantations are already large enough to invite attacks by Ips and other barkbeetles. The hazard of attack by barkbeetles coming in from nearby pine areas has been pointed out in several memoranda.

1. Pine engraver, (Ips confusus Lec.)

So far attacks by Ips have occurred only in a few of the large ponderosa pines which were on the grounds at the time the Institute was started and have been used for breeding purposes.

In August 1939 a large pine on the west side of the seed laboratory was killed down for about 30 feet from the top by Ips confusus. The top was cut out and the broods of beetles in the infested portion were destroyed. In 1943 Weidman reported the prevalence of top-killed ponderosa pines in the general area around the Institute. This was investigated and found to be caused by a mild outbreak of Ips confusus. No trees on the Institute property, however, were attacked and the outbreak subsided the following year. In 1946 another large ponderosa pine was top killed just east of the staff house and the top was removed. The only feasible control of these top-killing Ips infestations is to destroy them promptly as they appear. A tree top killed by Ips sets up a hazard of further attack by Ips and the western pine beetle in lower bole, and to some degree the chances that this will occur are reduced by destroying the initial infestation in the top.

2. The western pine beetle, (Dendroctonus brevicomis Lec.)

Occasional ponderosa pines have been killed by this beetle in the surrounding area. In 1943 there was some correspondence between Weidman and F. P. Keen regarding prevention of these Ips-western pine beetle attacks on the properties of the Institute. Disposal of green slash which might be created within a mile or two of the Institute, to prevent breeding up of these barkbeetle populations, was recommended as an important preventive measure.

3. The red turpentine beetle, (Dendroctonus valens)

a. Occurrence

This beetle was first found attacking the older trees in the arboretum in 1943 when a total of 90 trees became infested. Most of the attack was concentrated in the western side of the arboretum nearest to the sawmill of the Placerville Lumber Company. During the seasons of 1943-44 a thorough study of selection of pines by the turpentine beetle and pitch moth was made by Weidman and Robbins. Results of this study have been published in the Journal of Forestry for June 1947. The beetle showed a definite preference for the introduced pines, rather than the native ponderosa or Monterey pines in which it commonly breeds. High on the list in preference were P. pungens, P. resinosa and P. banksiana. Control work was started, the method used consisting of removal of the bark over the egg-galleries and coating the wound with tree-heal. In 1944 only 17 trees were attacked. The beetle will probably always be present in the pine planted areas of the Institute.

b. Nature of injury

The turpentine beetle is attracted to fresh stumps when trees are cut in thinnings. It breeds successfully in the stumps, and when the new beetles emerge they usually attack near the base of adjacent living trees and make conspicuous pitch tubes.

Vigorous trees overcome this attack by pouring copious resin into the wounds made by the beetle which is finally "pitched out" by the resin flow. Weakened trees, however, will succumb and the beetle breeds successfully in these as it does in stumps.

A. Control

On living trees the beetle makes its attacks within 10 feet of the ground, so that it is easily reached by control measures designed to destroy the beetle and its broods under the bark.

The simplest, cheapest and most effective method is to dig out the adult beetles by removing the bark over their entrance galleries, kill the adult beetles by crushing, and scrape the wound to destroy any eggs and larvae. A good protective measure is to paint the wound with an asphalt "tree heal". However, other measures for accomplishing the same result are fumigation with a gas such as carbon tetrachloride, but this method has no advantages over the "digging out" procedure. Carrying out any of these control measures, however, is largely a waste of effort on vigorous, resistant trees in which the beetles are unable to produce broods. Vigorous trees seal over the cambial wound with resin and the attacking adults usually die in this pitch flow. As long as trees in plantings of the Institute are in a vigorous growing condition there

is little danger of their being killed by the turpentine beetle. In the case of weakened trees in which eggs and larvae have become established control is the best policy.

4. Pitch moth, (Vespamima sequoia)

a. Occurrence

This clear winged moth is common in the Placerville area in ponderosa and digger pines. When pruning the arboretum trees was carried out in 1940-41 it was attracted to the scars where the limbs were cut. By 1943 a very general infestation had built up and control was undertaken with hand labor. A great number of pine species were attacked, the greatest preference being apparently for exotic species, according to the records compiled by Weidman and Robins. The only native California pine that rated high in selection by the pitch moth was digger pine, P. Sabiniana.

b. Nature of injury

The adults are attracted to fresh scars and wounds and the eggs are usually deposited along the edge of these wounds or in nearby bark crevices. The larvae establish themselves in a cell-like mine in the inner bark, in which a constant pitch flow is maintained by the tree. The operation is fairly comparable to a turpentine facing. In some way the larvae obtains its nutrition from the sap flow, but the surplus resins accumulate around the mine and eventually form a large pitchy mass. Full grown larvae are yellowish white, about two-thirds of an inch long. From eggs deposited in July, the larvae become full grown the following spring and pupate on the surface of the pitch mass. The moths begin to fly in June.

c. Control

Hand picking of the larvae from the pitch masses is the only method of control that has been used. In the 1943-44 control work the scars were scrapped and covered with tree-heal, but it was found that the moths readily re-attacked around the edges of the same scars. A repellent mixed with the paint used in covering the wounds would probably make control work more effective, but no such formulas has yet been developed. The pitch moth population in the arboretum was greatly reduced by the control work of 1943-44 and at the present time is not a serious factor in the plantings.